

A Look at Aluminum

Activity 52

Aluminum is a nonrenewable, but recyclable, natural resource that we use every day. In this activity, students sequence the steps that go into making aluminum products and participate in a service learning project to encourage aluminum recycling in their community.

Levels

Grades 5-8

Subjects

Science, Social Studies

Concepts

- Resource management and technological systems help societies to meet, within limits, the needs of a growing human population. (3.6)
- Conservation technology enables humans to maintain and extend the productivity of vital resources. (3.7)
- All humans consume products and thereby affect the availability of renewable and nonrenewable natural resources. (2.11)

Skills

Discussing, Analyzing, Ordering and Arranging, Making Analogies and Metaphors, Restructuring



Technology Connections

Graphic Organizer Software, Graphics Software, Presentation Software

Materials

Copies of student page, scissors, aluminum cans (one for every four students), pens and paper, art supplies, chart paper, containers (optional), phone book, Yellow Pages (optional), can crusher (optional), boxes or plastic bags (optional), and magnets (optional)

Time Considerations

Preparation: 30 minutes
Activity: One or two 50-minute periods with possible extended projects

Related Activities

A Few of My Favorite Things; Resource-Go-Round; Make Your Own Paper; Reduce, Reuse, Recycle; Renewable or Not?

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OBJECTIVES

- Students will understand the environmental impacts of producing new aluminum and recycling aluminum products.
- Students will describe the steps involved in both creating and recycling an aluminum can.

ASSESSMENT OPPORTUNITIES

- Students apply the knowledge they gained in the activity to answer these questions:
 - What are the qualities of aluminum that make it such a good material to use? (abundant in Earth's crust, lightweight, strong, doesn't corrode, increases energy efficiency of planes and cars, recyclable)
 - What are some negative trade-offs of aluminum production? (requires an enormous

amount of electricity to produce, results in a large amount of red mud, pollutes air from associated power and processing plants)

- What are the advantages of recycling aluminum cans instead of creating new cans from bauxite? (It takes 20 times more energy to process new aluminum than to recycle it.)
- Based on what you've learned about aluminum, what conclusions might you draw about the environmental effects of other products that you use and the materials that went into making them? (Students should realize that manufacturing finished products involves many steps and much energy, and that there can be ways to make or reuse products that have less negative environmental impact than others.)
- Students use graphic organizer software to create a flowchart of how an aluminum can is made and what happens to it after it is used.

BACKGROUND

Aluminum is an important material used in many different products. In addition to aluminum cans and other food containers, aluminum is used to make airplanes, automobiles, bridges, buildings, doors, windows, circuits for electronics, and many other products.

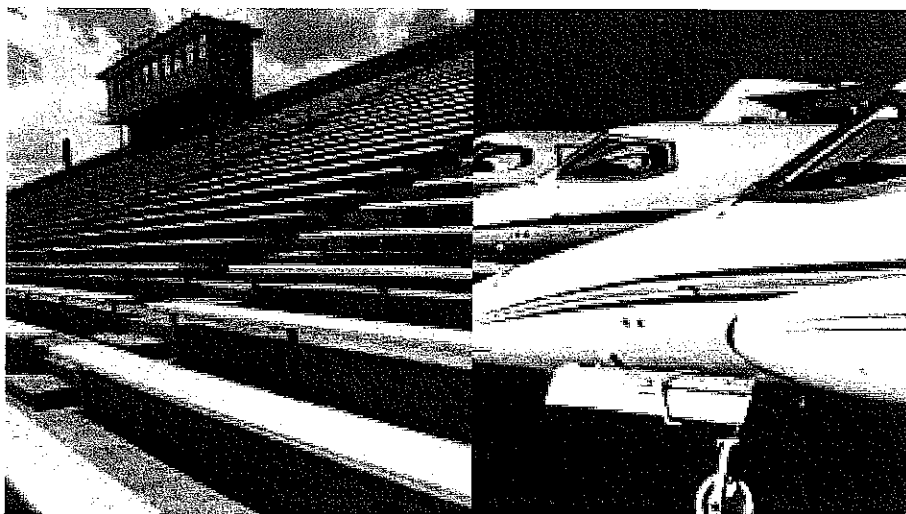
There are many steps involved in making aluminum products, starting with the mining of **bauxite** ore from the Earth's crust. The bauxite ore is refined into a powdery substance called alumina, and then electrolytically reduced into metallic aluminum, usually in the form of ingots or rods. These aluminum rods or ingots are then melted down or forged into the final aluminum products. (See the student page for details on aluminum production.) Two to three tons of bauxite are required to produce one ton of alumina, and two tons of alumina are required to produce one ton of aluminum metal.

Aluminum has a number of special properties that make it suitable for so many applications:

- It is lightweight, yet strong.
- It is resistant to corrosion.
- It is nonmagnetic and a good electric conductor.
- It can be rolled, squeezed, and cut into almost any shape.
- It is abundant in the Earth's crust.
- It can be recycled over and over.

However, there are also costs associated with using aluminum as a resource. Processing aluminum takes a tremendous amount of energy. In addition, mining and refining bauxite disturbs significant areas of land, emits dust and corrosive materials; and creates large amounts of alkaline residue (called red mud). While environmental controls help to mitigate these environmental effects, they do not completely alleviate them.

Bauxite occurs mainly in tropical and sub-tropical areas. The world's largest producer of bauxite is Australia, which provides about one-third of the total supply. Guinea, Jamaica, and Brazil combined provide another one-third. Aluminum production facilities are located all over the world, usually in areas where there are abundant supplies of inexpensive energy.



Recycled aluminum saves about 95 percent of the energy needed to make new aluminum from ore, reduces the amount of solid waste in landfills, and lessens the environmental impacts of aluminum production. In the recycling process, aluminum is melted down to form ingots or rods, which are later remelted and formed into new products. Recycled aluminum can also be melted directly into new products. (See the box below for additional information.)

Even if your area already has a recycling program, many aluminum cans are probably not getting recycled. In 2000, 100 billion aluminum cans were produced in the U.S. Of these, 64 bil-

lion (around two-thirds) were recycled by consumers.

GETTING READY

Make copies of the student page and assemble the materials for the activities. For Part B, see the PLT GreenWorks! Guide at www.plt.org for suggestions on planning and carrying out a service learning or action project.

DOING THE ACTIVITY

Part A—Resource Story

1. Divide the group into teams of four and give each team an aluminum bev-

erage can. Students should examine the can for a few minutes. Which parts of the can are more rigid and which are more flexible? How many separate pieces seem to make up the can? What material is it made of? Is it made of more than one material? How do you think a can is manufactured?

2. Have groups share their answers to the questions. Make sure students understand that the can is made of aluminum, that an aluminum can has three separate pieces (cup, end, and tab), and that different parts of the can are more or less rigid depending on the thickness of aluminum.

3. Ask students if they know where aluminum comes from. Do they know how it is made? Review the information in the Background section.

4. Give a copy of the student page to each team. Have students sequence the steps needed to produce aluminum and make an aluminum can. You may want to have them cut apart the steps to help in the sequencing.

5. After the students have figured out the order of the steps used in processing aluminum, have teams create their own visual representation of how an aluminum beverage can is made—from bauxite in the ground to a finished can of soda. They can use the

Aluminum Trivia

- Aluminum is the most abundant metal in the earth's crust.
- Aluminum is used in many products, from siding for houses to highway signs and airplanes.
- Aluminum can be remelted and reformed into new products over and over again without losing its strength.
- Aluminum cans represent only one percent or so of the total landfill volume today.
- The modern aluminum can will hold the weight of a 250 pound person.
- Since 1972, the aluminum industry has reduced the amount of aluminum needed to make each aluminum can by almost 52 percent.

Energy Facts

- Reprocessing (recycling) used aluminum saves 95% of the energy needed to process new aluminum from bauxite.
- If people in the United States recycled all the aluminum cans they currently throw away each year, they'd save enough energy to power a city the size of Baltimore, Maryland for one year.
- Aluminum is used extensively in the construction of cars, airplanes, boats, and other vehicles, making them lighter and more fuel efficient.

Information adapted from *The Aluminum Association's Information Website*. www.aluminium.org

ictures on the student page to help them draw some of the machinery involved.

They might also use graphics software or presentation software to show the steps.

Part B—Cash Cans

1. Ask students whether they know if your community has an aluminum recycling program. If it does, ask them how the aluminum cans are collected and whether they think many people participate. Ask students what actions they could take to launch a recycling program, or to encourage more participation if a program already exists.

2. Explain to students that they will be conducting a service learning project

to increase aluminum recycling in your community. Help the class decide on a goal for the project. Depending on your situation, students may want to initiate a recycling program at your school, work to increase the number of cans received at a local collection center, or collect and recycle cans as a fundraiser.

3. Ask students to name the benefits of aluminum recycling, and list these on the chart paper. They may want to use this information in any promotion materials for the project.

4. Also on the chart paper, begin a list of steps and tasks for the project.

Leave space to write in the names of volunteers for each task. The specific steps and tasks will depend on your project goals. See the box below for suggestions.

5. Help students to carry out the planned project.

6. After the project is complete, have students reflect on the process and results. In what ways has the project been successful? How do students know? What has been a challenge? What have students learned from doing this project?

Answers for student page

Proper sequence of pictures on student page: C, G, M, A, J, F, I, K, D, E, L, B, H

Project Suggestions

- Identify aluminum recycling centers in your area by checking the Yellow Pages under recycling, aluminum, resource recovery, or scrap metals. For each center, find out rates, hours of operation, and procedures for collecting in cans. You might use spreadsheet software for keeping track of this information.
- Contact an appropriate state or local government agency (such as the Department of Natural Resources, Department of Environmental Protection, or the Department of Public Works) for assistance.
- Create posters that illustrate why people should consider recycling aluminum cans, describe how local residents can recycle, or describe the environmental benefits of recycling. Include information from the Background, box on the previous page, or the student page.
- Before you begin collecting cans, make sure you have a good place to store them (such as a garage). You can save space by crushing your cans; most recycling centers will accept crushed cans, but always check first. To save time and gas, wait until you have a large quantity of cans before you return them to the center. Load your cans in boxes or large plastic bags that you can use again.
- Make sure all products you collect are made of aluminum. Most aluminum cans are designed with a recycling symbol. When in doubt, check with a magnet. Unlike steel cans, aluminum cans are not magnetic. Be sure to test the magnet against the side of the cans because steel, or bi-metallic, beverage cans have aluminum tops.

READING CONNECTIONS

Foster, Joanna. *Cartons, Cans, and Orange Peels: Where Does Our Garbage Go?* Houghton Mifflin. 1991. Outlines the composition of garbage and trash and discusses the various methods of disposing it with an emphasis on recycling. Grades 2-7. ISBN: 0395665043.

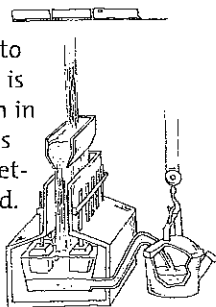
Kouhouth, Rudy, Donald B. Marti, and Donald B. Marti Jr. *How On Earth Do We Recycle Metal?* Millbrook. 1992. Examines the problems associated with the disposal of metal waste and describes how it can be recycled by creating objects such as jewelry, weathervanes, and Christmas ornaments. Grades 3-6. ISBN: 1562941429.

Palmer, Joy A. *Recycling Metal*. Scholastic. 1991. Explains the environmental problems that result from the manufacture and disposal of everyday items made of metal and shows how the recycling of these objects can reduce these threats. Grades 4-8. ISBN: 0531141187.

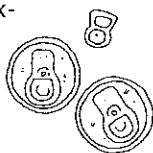


The Making of an Aluminum Can

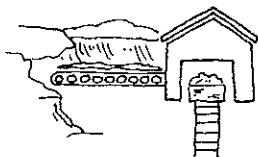
A. Smelters, or reduction plants, transform white alumina powder into molten aluminum. First, the powder is dissolved in a hot liquid salt solution in a "pot", then an electric current flows into the pot, causing aluminum to settle to the bottom where it is removed. This process takes a large amount of energy.



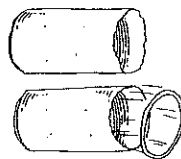
B. Can ends are fed through a high precision process where rivet making, scoring, and tabbing occur in consecutive operations.



C. Bauxite, the mineral from which aluminum is made, is mined from open pits called strip mines. Trees and other plants, rocks, and soil are first cleared away. Then the bauxite ore is extracted from the earth and taken to processing plants.



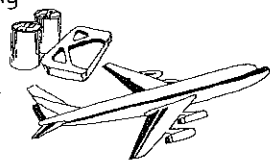
D. Cans are spun as a cutting tool trims the rough shell from the inside.



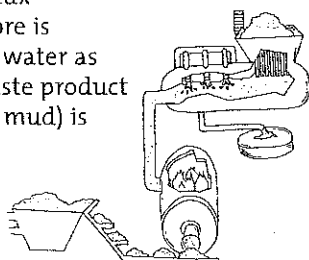
E. A "neck" is made at the top of the can to reduce the diameter, and then flanged out so that it will be the right size and shape for the can end.



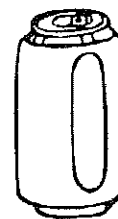
F. The aluminum is prepared for turning into products. For beverage cans and other products like foil and airplanes, huge slabs of aluminum are rolled into sheets of varying thickness. For other products like tea kettles or car parts, ingots are melted and poured into molds.



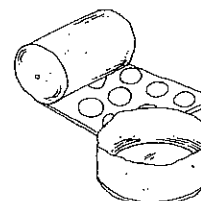
G. After crushers mash bauxite ore into small bits, the ore is heated to remove as much water as possible. At this stage a waste product called bauxite residue (red mud) is left behind.



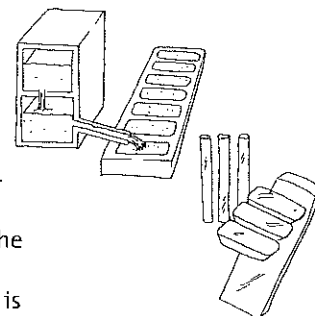
H. The cans and lids go to a bottling plant. There, the cans are filled with the beverage and the lids are secured onto the cans.



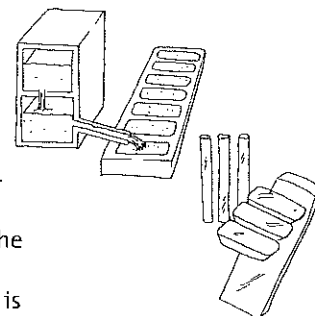
I. A coiled sheet of aluminum is fed through a press that punches out shallow cups, which will form the bottom and sides of the can.



J. Molten aluminum is usually alloyed (mixed with other metals and elements) to make it stronger. Then it is poured into molds to form ingots. Ingots may be long rods, huge slabs weighing 20 tons (18,144 kg), or small bricks weighing only 4 pounds (1.8 kg).



K. Cups are fed into an ironing press where successive rings pull and iron the sides of the cup, reducing the sidewall thickness to get a full length can. The bottom is domed for strength.



L. Ends are stamped out of a pre-coated aluminum coiled sheet. A compound is added to assure a perfect seal between the can and the end when they are attached.



M. The crushed bauxite goes through a series of chemical reactions in a refinery, turning it into a fine white powder called alumina. The refining process creates large volumes of bauxite residue (red mud), which is made of silica, iron oxides, and other impurities from the bauxite ore.

